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1 RECORD OF ORAL HEARING
2 UNITED STATES PATENT AND TRADEMARK OFFICE
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4 _____
5 BEFORE THE BOARD OF PATENT APPEALS
6 AND INTERFERENCES
7

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9 *Ex Parte* TIMOTHY J. PHILLIPS and TIMOTHY ASHLEY
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11 _____
12 Appeal 2009-007560
13 Application 10/577,938
14 Technology Center 2800
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16 _____
17 Oral Hearing Held: April 13, 2010
18

19 _____
20 Before MARC S. HOFF, CARLA M. KRIVAK, and
21 THOMAS S. HAHN, *Administrative Patent Judges*.
22

23 APPEARANCES:
24

25 ON BEHALF OF THE APPELLANT:
26

27 STANLEY C. SPOONER, ESQUIRE
28 Nixon & Vanderhye, P.C.
29 11th Floor
30 901 North Glebe Road
31 Arlington, Virginia 22203

1 THE USHER: Calendar No. 8, Appeal No. 2009-007560,
2 Mr. Spooner.

3 JUDGE HOFF: Good morning.

4 MR. SPOONER: Good morning. My name is Stanley Spooner. I'm
5 representing the assignee of record which is QinetiQ Ltd., a UK R&D
6 Company. The invention that we're talking about, or purported invention,
7 relates to semiconductors; in particular, narrow band gap semiconductors
8 which are subjected to strain. All right, application of strain to
9 semiconductors is an established way of altering the characteristics in the
10 band gap. That's described in Applicants' specification page 1, lines 15 and
11 16. Tensile strain semiconductors are known and they're detailed in the
12 specifications, such as the MOSFET disclosed in U.S. Patent 5,382,814. But
13 there, the induced strain is in a wide gap, a wide band gap device, and it
14 specifically states that it doesn't change the operation of that device. And
15 that's at the specification page 1, lines 16 to 24. Our Applicants found that
16 placing a transistor's narrow band gap region, not a wide band gap but a
17 narrow band gap region, under compressive strain provides significant
18 benefits, especially for a P-doped, or excess hole band gap region. And,
19 that's at the Application page 2, lines 1 to 3.

20 All right, so, the critical features of the invention that we're talking
21 about today is that it's a narrow band gap region, that it's under compressive
22 strain, and that that region is comprised of doped P-type material or a
23 material containing an excess of holes. All right, that's clearly set out in the
24 first -- well, in the body of Claim 1 and the first 3 lines of Claim 16. The
25 Examiner has a rejection. Anticipation is the basis under Section 102 of
26 both of these Claims, by two Phillips references. And Mr. Phillips, the

1 Inventor in -- or at least co-inventor, in those references, is a co-inventor of
2 this one. So, this is something that he has improved upon. So, the question
3 is, do either of his previous references disclose every element and every
4 interrelationship between elements that we Claim. And, our contention is
5 that it doesn't. Now, the Examiner dropped the 112 rejection in the
6 Examiner's Answer, and I would just note that the issues regarding that 112
7 rejection were raised in a pre-appeal brief -- supporting statement. The
8 Examiner, and the panel who reviewed it, apparently ignored it because they
9 passed the whole thing on. But, in any event, turning to the Appeal Brief
10 and the Reply Brief, Sections B and C, it might be helpful to understand
11 what we're talking about, in terms of band gap.

12 If we draw a diagram such that the horizontal is density -- the state
13 density, and vertical is the electrical energy required to shift bands and, if the
14 lower area is the valence band and, if the higher area is the conduction band
15 -- I think I learned this in physics sometime but I've forgotten it since, so, it
16 helps to go through it a little bit. The electrons are in clouds, in valence
17 clouds, around a nucleus. For something to conduct, an electron has to get
18 knocked off of that band, the valence band, so that it is free to conduct. And
19 so, this is an energy difference between the electrons in their valence bands,
20 and the electrons that have been knocked loose, so as to provide a conductor.
21 All right, for metal materials, or other common conductors, there is no gap
22 here. This conduction band is right here, so it doesn't take any increased
23 amount of energy. You apply a potential and you get a current flow. For
24 insulators, you have a very wide band gap, this gap between the two bands.
25 That's an insulator. It takes an awful lot of energy to break down that
26 insulator and get an electron to move from the valence to the conduction

1 band. Semiconductors have fairly narrow bands and, depending upon their
2 construction and everything else, you can move electrons in certain
3 circumstances, from the valence to the conduction band. So, it does provide
4 conduction to some extent. It's either a variable insulator or a variable
5 conductor, however you want to think of it. We're concerned with a fairly
6 narrow subset, narrow band gap, semiconductors. Applicants identified, in
7 their research, as evidenced by their previous patents and patent
8 publications, that you can bias the quantum well, bias both a quantum well
9 field effect transistor, and a bipolar transistor. So that, by the use of
10 differing doped compounds, and that's doping is different from the doping of
11 this narrow band gap region semiconductor material. So, typically, they
12 may be made of indium antimony or indium antimony aluminum --
13 aluminide. The presence of that three- component layer in amongst a bunch
14 of two-component layers, in other words indium antimony, antimonide, well
15 -- the, the lattice structure of the surrounding layers is smaller than the lattice
16 structure of the sandwich layer. And so, you grow these layers by epitaxial
17 growth, or something like that, so that the crystalline structure lines up; and
18 what happens is when you put this narrower construction, this smaller
19 lattice, down, and then you put a layer of the indium antimonide -- antimony
20 on there, it constrains it. It squeezes it in to fit with the latticework of the
21 underlying layer. And the same thing, if you put another layer on top of it,
22 of the underlying material, it also squeezes it a little bit more so that the
23 lattice connections line up. That, basically squeezes, or puts under
24 compression, that intermediate layer.

25 So, that's what the Applicant's invention is doing. How you get
26 compressive strain depends upon the construction -- alloy that you're using,

1 the ratios of the various alloys. It also depends on the relative thickness.
2 We'll see how that's significant in one of them. If we look at the Phillips
3 '674 patent, and that's -- by the way, that's discussed in our specification, on
4 page 2, line 17, since it's one of our co-inventors' own publications. And,
5 the Examiner has cited page 10 and figure 7 of Phillips '674 as being
6 particularly pertinent. And, if we look at that, it shows layer 22, which is the
7 narrow band gap region; and that's indium antimony, and then the regions
8 around it, 21 and 23, below and above it are the indium aluminum antimony
9 alloy. So, the presence of those alloys, above and below, will compressively
10 squeeze that inner layer, which is the narrow band gap region. That the --
11 what they call the principal conduction channel. However, he specifically
12 states, on page 10, that with regard to figure 7, that it's not doped, he says
13 undoped indium antimonide, I guess is the way you pronounce it. So, that's
14 at line 17, on page 10. And, he then says that that combination of elements
15 and thicknesses, and concentrations in the alloy, provides "strained
16 balanced" at the lattice constant -- of that alloy. In other words, he
17 specifically says no compressive strain and no doping of that narrow band
18 gap area. So, in our view it's impossible to have anticipation with that
19 reference, with the '674 reference.

20 JUDGE HOFF: Counsel.

21 MR. SPOONER: Yes, sir?

22 JUDGE HOFF: Does your specification define compressive
23 mechanical strain?

24 MR. SPOONER: It's a well known term of art. It's not been
25 contested by the Examiner. And, as we discussed in the background, it is
26 known to strain. Mostly, it's known to tensilely strain these things, and we

1 provide an example of that, so the issue of how much is compressive and
2 how much is strain is sort of relative, but it's a well known term of art, I
3 believe. It's not been raised thus far. So, if we turn to --

4 JUDGE HAHN: Counsel. Counsel.

5 MR. SPOONER: Yes, sir?

6 JUDGE HAHN: In that same vein, what does strain balanced mean?

7 MR. SPOONER: Strain balanced means that the -- it's a term of art.
8 It means that the strain is the same. That there is no strain. That, that it's
9 balanced. We had another case that was -- went up before the Board --
10 where they introduced purities, or impurities, in the latticework to get the
11 strain in, in -- I think it was -- or solar panels, to get the latticework of
12 different doped layers to be the same. So that you didn't strain them.
13 Because, what happens is if you strain them, in other words one is
14 compressive, one is bigger, it causes dislocations and reduces the conduction
15 of the solar cell.

16 Here, we're using strained balance in exactly the same way.
17 It means the latticework or the lattice constant of the narrow band gap area,
18 or as he calls it, the conduction area, is the same as the above and below
19 layers. So there is no compression or tension. It's the same. It's strain
20 balanced.

21 JUDGE HAHN: Okay. Now the specification, as I understand it,
22 says that if you have an indium antimonide layer sandwiched between two
23 indium aluminum antimonide layers, there will be compressive strain.

24 MR. SPOONER: Yes. That's the explanation of how the invention
25 works.

26

1 JUDGE HAHN: Okay. So, what we're looking at here, at Phillips
2 '674,

3 we don't have that structure, do we? Because if we did we would have
4 compressive mechanical strain, would we not?

5 MR. SPOONER: Yes, sir. Yes, sir. Absolutely. Firstly, we don't
6 have -- we do have the sandwich of indium antimonide between the other
7 two layers, but we have thicknesses and we have concentrations of the
8 materials in the top and bottom layers that are strain balanced. In other
9 words, you could change the characteristics, the percentages of the indium
10 aluminum and antimony in that alloy, and you could come up with a strain
11 inducing layer with respect to the indium antimonide. But, they teach it.
12 They teach the opposite. They say you want strain balance, so that you don't
13 have this problem with dislocations and other things of that nature. They
14 also specifically say it's undoped indium antimonide. And our Claim, of
15 course, specifically requires that it either be P-type or have an excess amount
16 of holes. And that may be saying the same thing. I think it's two different
17 ways to say the same thing.

18 So, yes, they show an arrangement of elements that, if they had doped
19 the center section and if they had gotten the right concentrations and/or
20 thicknesses to provide compressive strain, they'd have our invention. And,
21 if Mr. Phillips had come up with it earlier, he'd have probably claimed it in
22 this disclosure.

23 JUDGE HAHN: Now, in the preceding paragraph, the last sentence,
24 he does mention an embodiment with strain and quantization effects
25 included. What are your positions with respect to that last sentence?

26 MR. SPOONER: Well, he doesn't say that it's compressive strength,

1 firstly. So, we have fifty-fifty shot at it being wrong. And, there's no
2 disclosure of any -- the -- indium antimonide being doped. So, I mean, he
3 mentions the word strain.

4 JUDGE HAHN: Yes. Yes.

5 MR. SPOONER: There is no doubt. But, there's no teaching of our
6 arrangement, which provides not only the compressive strength but the P-
7 doped narrow band gap region.

8 JUDGE HAHN: Okay. Counsel, with respect to the doping of the
9 indium antimonide, we noticed in the Reply Brief that that argument was
10 made. Was that argument made prior to the Reply Brief? Was it in the
11 Appeal Brief or raised during prosecution?

12 MR. SPOONER: Can you point me to where, in the Reply Brief?

13 JUDGE HAHN: I'd suggest page 6? Possibly the last sentence of the
14 first full paragraph, "While the Examiner is correct in noting that the
15 elements contained in the differing layers are the same elements it doesn't
16 indicate the existence of any P-type material or excess hole material."

17 MR. SPOONER: Right. I think that's a correct statement. Whether it
18 was made in an Appeal Brief or an Amendment, that's hard to say -- I can
19 take a look. All I can see in the Appeal Brief we've referenced the language
20 that says -- he said -- actually the reference says "it should be noted that, in
21 all cases, the layers are nominally undoped but may contain unintentional
22 doping of either type." So, he suggests that slightly less than perfectly
23 purified alloys could be used. But, there is no teaching of the doping. As to
24 whether the Examiner understood that argument or was responding to it, I'm
25 just not sure. But, I think we put that in there because the Examiner stated,
26 in his Answer -- I think it's subsection 2, he stated that

1 "if the composition is physically the same, it must have the same properties."

2 And, he's right. If the composition was shown, it must have the same
3 properties. But, the composition wasn't shown.

4 JUDGE HAHN: And your argument being because it wasn't shown to
5 be doped?

6 MR. SPOONER: It wasn't shown to be doped and it wasn't shown in
7 the concentrations that -- or the thicknesses -- that will result in compressive
8 strain. So, it's those two features that are missing. You would have to get to
9 a particular combination of percentages in the alloy, plus the thickness
10 necessary, so that that would actually compressively strain this narrow band
11 gap region. And, that's what they've missed. And what the Inventor
12 subsequently discovered. And, again, in that case, the Examiner -- in each
13 of these instances we've asked the Examiner to tell us where it is? Where it
14 is? Show us where there is any disclosure of doping of this narrow band gap
15 region.

16 JUDGE HAHN: Could you cite to that, please?

17 MR. SPOONER: Excuse me. Where?

18 JUDGE HAHN: Yes, where in the record?

19 MR. SPOONER: I'd have to go back through all of the Amendments.

20 JUDGE KRIVAK: Can I help? Is it page 9 in the Appeal Brief, right
21 below where you just read?

22 MR. SPOONER: Yes, your Honor. That's where I was. There's no
23 disclosure in Phillips '674 that there is any doping which would inherently
24 provide "at least one narrow band gap region under compressive mechanical
25 strain."

26 Again, should the Examiner persist in this unfounded allegation, he is

1 respectfully requested to indicate specifically where any such teaching exists
2 in Phillips '674. And, then, that subsequent discussion -- it is possible that
3 because Phillips '674 combination of elements is similar to the combination
4 of elements set out in the present specification. The Examiner may believe
5 that "compressive mechanical strain" is somehow inherently disclosed in
6 Phillips. However, as discussed in the present specification, on pages 4 and
7 5, variations in the layer thicknesses as well as differing lattice
8 content -- constants of the materials can be combined to provide types of
9 mechanical strain, both compressive and tensile. But, it's not recognized that
10 compressive mechanical strain would have any disclosed benefits. So,
11 Phillips '674, you would have to decide, okay I'm going to P-dope or
12 provide excess to the band gap region semiconductor material and I'm going
13 to use sandwiching layers that give you a compressive strain. And he would
14 have to do both of those to come up with our invention. Thank you for the
15 cite; I was a page early.

16 All right. And again, the Examiner has had the opportunity to tell us,
17 in the Examiner's Answer, and he just didn't. So, I'm assuming that he can't
18 find -- that there is nothing in there. If we look at Phillips '337 -- if you add
19 up -- and it talks about a P-plus doped layer in there. But he also talks about
20 that layer as being 0.12 microns thick. And then he has a number of other
21 layers which are all alloys, having the different thickness, and they are so
22 significantly thicker that you wouldn't have the compression. In other
23 words, he has a lower layer and then he has these layers stuck on the end of -
24 - on the sides of it. And, as we pointed out in the Brief, the InAlSb layer is
25 less than .0004 of a percent of the thickness on the left and less than .00012
26 percent of the total thickness on the right. So, the question is, will that layer

1 compressively strain the band gap region? I don't think so. There is no
2 evidence introduced by the Examiner that that very thin layer will introduce
3 any compressive strain to the much thicker InSb layer 12. The Examiner
4 admits, in his Answer, page 6, the end of section C, that he has no evidence
5 to support his opinion. He says, "while this not explicitly stated in the
6 rejection it is implied in view of the previous analysis and statements."
7 Now, I can't fight with implications but I think the burden is on the
8 Examiner, to show us where this is. Where both of those things are. And,
9 he just hasn't done it.

10 So, I don't think that there's a prima facie case of anticipation because
11 all of the claimed elements and claimed interrelationships aren't shown.
12 Clearly, if there's no anticipation and those elements are not shown in one or
13 more of the references, they're certainly not going to be obvious in view of
14 the references. And actually, both references actually teach away from the
15 claimed invention. So even if he were to show somewhere where they
16 existed, the '674 patent teaches undoped and strained balanced; so both of
17 those teach away. And the '337 teaches doped but unstrained layers whether
18 compressive or tensile. So, I just --

19 JUDGE HOFF: Counsel. Your time is about to expire, if you'd like
20 to take about another minute to wrap up.

21 MR. SPOONER: I'm done. That's my wrap-up.

22 JUDGE HOFF: Very well.

23 MR. SPOONER: Any other questions?

24 JUDGE KRIVAK: None for me.

25 JUDGE HAHN: Counsel. The thickness argument, was that made in
26 an Appeal Brief? Help these poor eyes.

1 MR. SPOONER: The thick -- I think that section that we just read, on
2 page 9, last full paragraph, midway down, it says however, as discussed in
3 the present specification

4 Whereupon, the proceedings, at 9: 31 a.m., were concluded.